The incidence of type 2 diabetes in the United Kingdom from 1991 to 2010

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Abstract

Aims

To characterise the incidence of type 2 diabetes in the UK over the previous 20 years; and determine if there has been an increase in people aged 40 years or less at diagnosis.

Methods

For this retrospective cohort study, patients newly diagnosed with type 2 diabetes between 1991 and 2010 were identified from the UK General Practice Research Database (CPRD). Patients were grouped into five-year intervals by year of diagnosis and age at diagnosis. A standardised incidence ratio (SIR) was determined (1991–1995=100). The percentage of newly diagnosed patients for each age group and aged ≤40 years was calculated for each five-year calendar period. The incidence rate by age and five-year calendar period was also determined.

Results

The overall SIR increased to 158 (95%CI 157–160, p<0.001), 237 (235–238, p<0.001) and 275 (273–276, p<0.001) for 1996–2000, 2001–2005 and 2006–2010, respectively. For those ≤40, the respective values were 217(209–226, p<0.001), 327 (320–335, p<0.001) and 598 (589–608, p<0.001). An increase in incidence occurred with increasing five-year calendar period. The incidence of type 2 diabetes was higher for males after the age of 40 and higher for females aged ≤40. The percentage of patients aged ≤40 years at diagnosis increased with each increasing five-year calendar period (5.9%, 8.4%, 8.5% and 12.4%, respectively).

Conclusions

There was a significant increase in the incidence of diagnosed type 2 diabetes between 1991 and 2010 and the proportion of people diagnosed at an earlier age has increased markedly.

Introduction

The incidence and prevalence of type 2 diabetes has been increasing in the UK.[1] Although the cause of type 2 diabetes is multi-factorial, it is largely related to obesity and physical inactivity.[2] There has been an increase in the prevalence of type 2 diabetes in children and adolescents, which is thought to be dependent on many factors such as obesity, diet, family history of diabetes, ethnicity, sedentary lifestyle, puberty, low birth weight and exposure to diabetes *in utero*.[3,4,5,6,7]

Studies in the UK secondary care population and the US have shown that the age of diagnosis of type 2 diabetes has decreased over time.[8,9] Early onset type 2 diabetes will result in afflicted people living a larger proportion of their lives exposed to the toxicity of dysglycaemia, such that their complications could conceivably more reflect those of people with type 1 diabetes; for example, increased rates of microvascular complications. The onset of type 2 diabetes prior to the age of 45 is an independent risk factor in the development of retinopathy after matching on diabetes duration and adjusting for traditional risk factors such as glycaemic control and hypertension.[10] In addition, youth onset type 2 diabetes in Pima Indians aged less than 20 years at diagnosis was associated with an increased incidence of end stage renal disease and mortality in middle age compared with older onset diabetes.[11] In terms of cardiovascular risk, early onset type 2 diabetes may constitute a more aggressive disease.[12 ,13]

This study aimed to characterise the incidence of diabetes over the past 20 years in the United Kingdom. We also aimed to determine if there was an increase in the proportion of people diagnosed with diabetes who were young.

Methods

Data source

Patients with type 2 diabetes were identified in the Clinical Practice Research Datalink (CPRD).[14] CPRD contains clinically rich data that are collected in a non-interventional way from the daily record-keeping of primary care physicians in the UK. These pseudonymised data include patient demographics and medical history, including diagnoses, test results and prescriptions. The data extract used for this study comprised records up to June 2011 and contained 143 million patient years of computerised data of acceptable quality for research purposes. CPRD checks the data to ensure it is of an acceptable standard and over 550 peer reviewed studies using CPRD have been published.[15] Ethical approval for this study by the CPRD Independent Scientific Advisory Committee was granted on 23/02/2012, protocol number 12_019R.

Selection criteria

Included patients had to be newly diagnosed with type 2 diabetes between 1991 and 2010, inclusively. Patients were attributed a diagnosis of type 2 diabetes if they met one of the following criteria:

1. A diagnosis of type 2 diabetes and a prescription for a glucose lowering medicine excluding insulin

2. Diagnoses for type 1 or type 2 diabetes or diabetes where type not specified and prescriptions for more than one type of glucose-lowering medicine excluding insulin

3. A diagnosis of type 2 diabetes, no diagnosis of type 1 diabetes, no prescription for exogenous insulin or a glucose-lowering medicine other than insulin

4. A diagnosis of type 2 diabetes, no diagnosis of type 1 diabetes, a prescription for a glucose-lowering medicine but no prescription for insulin

5. A prescription for glucose biosensor strips and a medication(s) used for diabetes but no diagnosis of diabetes and no prescription for insulin

6. A diagnosis for type 2 diabetes, a diagnosis of type 1 diabetes but no prescription for insulin

7. A diagnosis of diabetes (type not specified) but no prescription for insulin.

Criteria 1, 3 and 4 include no conflicting diagnoses. Criteria 2 uses conflicting diagnoses but is based on the assumption that the use of at least two different OHAs confirms the type 2 diagnosis. Criteria 5, 6 and 7 are included as patients not treated with insulin cannot have type 1 diabetes.

Type 2 diabetes incidence

The incident date of diabetes was taken as the earliest of either the date of diagnosis of diabetes or the date of the first diabetes-related prescription (glucose biosensor strip, OHA or insulin). Cases also had a minimum 'wash-in' period of one year between the incident date and the latest of the patient registration date and practice up-to-standard date.

Patient data were categorised into five-year intervals by year of diagnosis and age at diagnosis. The percentage of all newly diagnosed patients in each age group was calculated

by dividing the number of patients diagnosed in each age group per five-year calendar period by the total number of patients diagnosed in the same relevant five-year calendar period. The percentage of patients aged ≤40 years at diagnosis was calculated in a similar way. Incidence rates were calculated yearly and by age group and five-year calendar period by dividing the number of incident cases by the number of person-years in CPRD for the same calendar year and age group where applicable. Patients were included in the person-years estimate (denominator) from one year following the latest of the up-to-standard date or the practice date until the earliest of their death date, date transferred out of practice or incident date of diabetes (patients need not necessarily have had contact with their general practice to be included). Incidence was compared within age groups over time by calculating an age-and-sex-stratified standardised incidence ratio (SIR), akin to a standardised mortality rate (SMR).

Statistical methods

Changes in SIRs were compared by means of the Byar approximation Poisson method. Statistical analyses were carried out using SPSS-18 and R[16]. Baseline characteristics were compared between five-year calendar periods using Mantel-Haenszel linear-by-linear chi-squared test for categorical variables and one-way ANOVA or Kruskall-Wallis test for continuous variables, depending on their distribution. Levene's test was employed to test for homogeneity of variances. If the assumption of homogeneity of variances had been violated and group sizes were unequal, Welch's F was used. Differences between five-year calendar periods were explored using Games-Howell procedure, which can be used when population variances and sample sizes differ. Kendall's tau-b was used to determine if there was a significant association between percentage diagnosed and five-year calendar period.

Confidence intervals for incidence rates were calculated using the Byar approximation method and for proportions using mid-P confidence interval adaptation of the Clopper-Pearson interval.

Results

Baseline characteristics

Baseline characteristics by year and age group at diagnosis are detailed in Table 1. In each five-year calendar period, slightly more newly diagnosed patients were female than male. For people aged ≤40 at diagnosis, body mass index (BMI) changed from a mean (SD) of 32.2 kg/m^2 (7.7 kg/m^2) in 1991–1995 to 29.2 kg/m^2 (5.3 kg/m^2) in 1996-2000 (p=0.649), 32.6 kg/m^2 (7.7 kg/m2) in 2001–2005 (p=0.003) and 30.8 kg/m^2 (6.1kg/m^2) in 2006-2010 (p<0.001). For people >40 at diagnosis, mean BMI increased with each successive five-year calendar period from a mean of 29.2 kg/m^2 (5.3 kg/m^2) in 1991–1995 to 30.8 kg/m^2 (6.1 kg/m^2) in 2006–2010 (p<0.001).

For patients aged ≤40 years at diagnosis, mean (SD) glycated haemoglobin (HbA1c) at baseline was 8.3% (3.0%) in 1991–1995, decreasing to 6.1% (2.2%) in 1996–2000 (p<0.001) before increasing to 6.7% (2.5%) in 2001–2005 (p<0.001) and 7.4% (2.6%) in 2006–2010 (p<0.001). For patients aged >40 years at diagnosis HbA1c was 9.0% (2.9%) in 1991–1995, decreasing to 7.6% (2.6%) in 1996–2000 (p<0.001), 7.5% (2.3%) in 2001–2005 (p<0.001) and 7.5% (2.2%) in 2006–2010 (p=0.776). Mean systolic and diastolic blood pressure and total cholesterol levels decreased in each five-year calendar period between 1991 and 2010 for patients aged >40 at diagnosis. For patients ≤40 at diagnosis, systolic and diastolic blood pressure and total cholesterol were lower in 2006-2010 than any other year. The number of GP contacts—an indicator of general morbidity—in the year prior to diagnosis of type 2 diabetes increased during the study period from a median (IQR) of 5.0 (2.0-9.0) and 6.0 (3.0-11.0) contacts in 1991–1995 to 7.0 (3.0-12.0; p<0.001) and 8.0 (4.0-15.0; p<0.001) contacts

in 2006–2010 for patients aged ≤40 and >40 at diagnosis, respectively. The time to first drug treatment for type 2 diabetes following diagnosis decreased from a median (IQR) of 0.4 (0.0-3.2) and 0.5 (0.0-3.1) years in 1991–1995 to 0.0 (0.0-0.3; p<0.001) and 0.1 (0.0-0.6; p<0.001) years in 2006–2010 for patients aged ≤40 and >40 at diagnosis, respectively. There was no change in the median score for the Charlson morbidity index during the study period for patients aged ≤40 years at diagnosis and decreased from 4.0 (3.0-5.0) in 1991-1995 to 3.0 (2.0-5.0) in 1996-2000, 2001-2005 and 2006-2010 for patients aged >40 at diagnosis. More patients had suffered from conditions that could be associated with a complication of diabetes prior to their diagnosis of type 2 diabetes in increasing five-year calendar periods and there was a significant difference between groups for coronary heart disease (CHD) (p<0.001), cerebrovascular disease (CVD) (p<0.001), diabetic foot and peripheral vascular disease (PVD) (p<0.001), eye-related complications (p<0.001) and end stage renal disease (ESRD) (p<0.001) for patients aged >40 at diagnosis.

Standardised incidence ratio

The SIR increased within each five-year calendar period from 1991–1995 (SIR=100) to 158 (CI 157–160, p<0.001), 237 (235–238, p<0.001) and 275 (273–276, p<0.001), respectively (Table 2). For those aged 40 years and under, the respective SIRs were 217 (209–226, p<0.001), 327 (32017–335, p<0.001) and 598 (589–608, p<0.001; Table 3).

Specific incidence rates

The incidence of type 2 diabetes increased between 1991 and 2002 from 169 newly diagnosed people per 100,000 person-years (95%CI 160–178) to 448 (95%CI 442–455) before decreasing to 376 (95%CI 371–382) per 100,000 in 2006 (Figure 1). By 2009, the incidence of type 2 diabetes had increased to 533 (95%CI 526–539) per 100,000 before decreasing slightly to 515 (95%CI 509–521) per 100,000 in 2010. The incidence of type 2 diabetes for males and females followed a similar pattern, but incidence was higher for males than for females. HbA1c levels at baseline were 9.3% (95%CI 8.5%-10.2%), 7.1% (95%CI 7.0%-7.1%), 7.7% (95%CI 7.6%-7.7%), 7.4% (95%CI 7.4%-7.4%) and 7.3% (95%CI 7.2%-7.3%) in 1991, 2002, 2006, 2009 and 2010, respectively

The incidence rate for type 2 diabetes increased with each increasing five-year calendar period for all age groups and for both genders, with the exception of females who were 90 years and over, where the incidence rate fell to 482 from 452 people per 100,000 in the final two five-year calendar periods (Figure 2a and 2b). Overall, between 1996 and 2005, the incidence rate was highest in the 70–74 age group at 892 and 1,415 people per 100,000 for 1996–2000 and 2001–2005, respectively. For 1991–1995, the incidence rate was highest in the 75–79 age group at 605 people per 100,000. In 2006-2010, the highest incidence rates were seen in the 70-74 and 75-79 age groups at 1486 per 100,000. After the age of 40 years, the incidence was higher in males for each five-year calendar period (Figure 2a and 2b). However, females had a higher incidence than did males for many of the age groups below 40 years, including the age groups between 20 and 39 years for all five-year calendar periods.

A larger percentage of patients were diagnosed between 65 and 69 years of age between 1991 and 2005 than any other age group. However, between 2006 and 2010, the most common age at diagnosis was lower, at 60–64 years. For males, the largest percentage of patients was diagnosed between 65 and 69 years of age from 2001–2005, but between 60 and 64 years of age for 1991–1995, 1996–2000 and 2006–2010 (Figure 3a). The largest percentage of females was diagnosed between the ages of 70 to 74 years for 1991–2005 (Figure 3c). This had decreased to 60–64 years of age between 2006 and 2010.

The percentage of patients aged 40 years or less at diabetes diagnosis increased with each increasing five-year calendar period for males (Figure 3b) and increased between 1991-1995 and 2006-2010 in females (figure 3d). However, there was no increase observed between 1996-2000 and 2001-2010. Overall, the percentage of patients diagnosed on or before the age of 40 years was 5.9% (95%CI 5.5%-6.3%), 8.4% (95%CI 8.2%-8.7%), 8.5% (95%CI 8.3%-8.6%) and 12.4% (95%CI 12.2%-12.5%) for 1991–1995, 1996–2000, 2001–2005 and 2006–2010, respectively. There was a significant association between five-year calendar period and the number of patients diagnosed before and after the age of 40 ($p<0.001$). However, there were differences between the incidence in males and females, where the incidence was higher in females at earlier ages.

Discussion

The incidence of diagnosed type 2 diabetes increased markedly between 1991 and 2010 in most age groups. Furthermore, the incidence rate increased with increasing age until 75 years of age. Importantly, not only was the overall incidence increasing, the proportion of people who were aged 40 years or less at diagnosis increased markedly.

The study results could reflect an increase in the incidence of type 2 diabetes in the UK population and a decrease in the age of onset. The incidence results are supported by incidence and prevalence rates previously demonstrated for the UK[1], US[17] and worldwide[18]. Conversely, between 2004 and 2006, the incidence of diabetes in Denmark has decreased slightly.[19] The primary modifiable risk factor contributing to development of type 2 diabetes is energy balance as measured by BMI as a proxy for obesity. In the general UK population, both the prevalence and severity of obesity has been rising since 1993.[20] Between 1993 and 2010, the proportion of the UK population who were estimated to be obese increased from 13% to 26% for men and 16% to 26% for women.[15] For children, the prevalence of obesity has increased between 1995 and 2010 from 11% to 17% and from 12% to 15% for boys and girls, respectively.[15] However, the percentage of adults meeting recommended levels for physical activity increased in the UK from 32% and 21% in 1997 to 42% and 31% in 2008 for men and women, respectively.[15] There is an inverse relationship between BMI and age of onset of type 2 diabetes[21] and intensive lifestyle intervention with a minimum of 7% weight loss and 150 minutes of physical activity per week reduced the incidence rate for diabetes by 58%.[22] A study based in Germany revealed that severe weight gain between the ages of 25 and 40 was associated with a higher risk of diabetes than if weight was stable in early adulthood and increased in later life (1.5 and 4.3 times the risk for males and females,

respectively) and the age at diagnosis was also lowered (five and three years for males and females, respectively).[23] For the study period, there was an increase in mean BMI at baseline for people diagnosed after the age of 40 for each successive five-year calendar period and both male and female weight increased in each five-year group during the study period. However, for people aged 40 years or less at diagnosis, the mean BMI fluctuated between five year calendar periods. A similar pattern was also observed for mean weight for both males and females in this age group. The decrease in 2006-2010 could be partly accounted for by the increased percentage of children and adolescents diagnosed in this five-year calendar period.

The increase in the incidence of type 2 diabetes and the proportion of patients aged 40 years or less at diagnosis may be due, at least in part, to increased screening for type 2 diabetes. Unlike type 1 diabetes, the symptoms of type 2 diabetes are not always obvious and the condition can remain undiagnosed for many years. A study carried out between 1978 and 1982 found that the actual onset of type 2 diabetes may be at least four to seven years before clinical diagnosis.[24] Therefore, any increased screening for type 2 diabetes may have an impact on how early diagnosis is achieved after onset of the condition. In the last decade, changes to the General Medical Services and Pharmacy Contracts, the implementation of the National Diabetes Framework, and local initiatives have increased the awareness of diabetes.[25,26] For example, the Quality and Outcomes Framework was introduced on 1st April 2004.[Error! Bookmark not defined.] In addition, changes have been made to the criteria for diagnosing type 2 diabetes during the study period. In 2000, the WHO new diagnostic criteria for the diagnosis of diabetes was implemented in the UK, which included lowering the threshold for diagnosing diabetes by fasting plasma glucose from 7.8 mmol/l to 7.0 mmol/l.[27] These

changes would have led to an increase in the number of patients diagnosed with type 2 diabetes, a reduction in the number of patients with undiagnosed diabetes and a decrease in the age at diagnosis. If the increase in incidence is a result of increased screening, this could be viewed positively as patients will receive appropriate diabetes care at an earlier stage of their disease. In support of this theory of an ascertainment effect, HbA1c levels at baseline followed an inverse pattern when compared with annual incidence rates for type 2 diabetes. However, it is important to note that there was a large amount of missing data in the earlier years of the study period Blood pressure and total cholesterol decreased throughout the study period, which may be an indication of increased screening for type 2 diabetes in patients who are already treated for hypercholesterolaemia and hypertension. The increased use of statins is likely to account for the reduction in baseline cholesterol seen during the study period. There is some concern that statin use may increase the incidence of diabetes, but despite this uncertainty, the benefits of statins on cardiovascular disease outweigh any possible diabetes risk.[28] During the study period, more diabetic complications have been recorded in relation to increasing five-year calendar periods. This could indicate a number of factors; for example, improved survival of patients with advanced disease, or patients suffering from more advanced disease at diagnosis. Improved recording of diagnoses in CPRD could also account for this trend.

Irrespective of the cause, the results of this study show that type 2 diabetes is common under the age of 40 years. Early onset type 2 diabetes could result in longer disease duration and lead to an increased risk of developing diabetic complications. This is likely to place an increasing burden on healthcare resources, and increased patient morbidity may lead to a poorer quality of life. An earlier age of onset of type 2 diabetes may also lead to mortality

occurring at a younger age. The Framingham Heart Study showed that the risk of CHD and CHD-related death increased with increasing duration of diabetes.[29] The Northern Manhattan Study found that diabetes duration was independently associated with an increased risk of ischaemic stroke.[30] In addition, youth onset type 2 diabetes has been linked to an increased risk of developing diabetic complications including cardiovascular disease and retinopathy.[8,13,12] The Vascular Risk Assessment and Management Programme called NHS Health Check has been gradually introduced in England for everyone aged 40 to 74.[31] However, it is important to consider if screening programmes should include patients under the age of 40 as earlier diagnosis will lead to the earlier initiation of appropriate diabetes care and treatment. Conversely, the results from the ADDITION-Cambridge trial demonstrated that screening people aged 40-69 at high risk of having undiagnosed diabetes was not associated with a reduction in all-cause, cardiovascular-related or diabetes-related mortality within 10 years.[32]

As already discussed, the main limitation of this study is the use of age of diagnosis to understand any trends in the age of onset of type 2 diabetes. In addition, the recording of measurements such as weight, BMI, total cholesterol, smoking status and BP improved during the study period. For BMI, the percentage of patients with a recorded BMI increased from 38% in 1991–1995 to 46% in 2006–2010 for those patients aged 40 years or less at diagnosis and this may be skewed as overweight patients are more likely to have their weight measured. Medical conditions like type 2 diabetes may be better recorded in CPRD in more recent years and this could have contributed to the increase in incidence rate over time. In addition, a consensus statement recommending the use of a DCCT-aligned Hba1c method in the UK was not published until 2000 and HbA1c levels in the early period may not

have been standardised throughout the UK.[33] Therefore, comparisons of mean HbA1c levels between five-year calendar periods should be interpreted with caution. One other study limitation concerns the allocation of a diagnosis of type 2 diabetes to patients in CPRD: in particular, the coding of diabetes may have changed in recent years. The term 'insulin-dependent diabetes mellitus' (IDDM) was used more commonly in earlier years, whereas 'type 1 diabetes' is now more frequently used. Some people with type 2 diabetes and receiving prescriptions for insulin may have been attributed a code for IDDM, leading to diabetes type being misclassified; this may exaggerate any increase in incidence seen during the study period. In addition, the criteria used in this study to attribute a diagnosis of type 2 diabetes to CPRD patients did not utilise BMI or laboratory data, which may have improved the classification of diabetes type.[34] Age was not used to classify diabetes type in this study as we were specifically investigating the proportion of people with type 2 diabetes in younger age groups.

The incidence of diagnosed type 2 diabetes has increased markedly and consistently. The proportion of very early onset type 2 diabetes continues to increase as a proportion of those diagnosed and these people have a greater opportunity to develop long-term complications.

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Contributor Statements

Design

CC was responsible for the study design. SH drafted the study protocol. CC and AB edited the study protocol.

Conduct/Data Collection

CC selected the data source. SJJ was responsible for data preparation

Data analysis

CC, CM and SH were responsible for data analysis.

Writing Manuscript

CC, CM, SH, JP, CP and AB interpreted the data. SH drafted the manuscript and others edited this version. CC approved the final version to be published and is overall guarantor.

Declaration of Competing Interests

The authors declare no conflicts of interest with regard to the objectives of this study.

Table 1. Baseline characteristics for patients diagnosed with type 2 diabetes before and after 40 years of age

Parameter	1991–1995		1996–2000		2001–2005		2006–2010		p-value	
	≤40	>40	≤40	>40	≤40	>40	≤40	>40	≤40	>40
N	642	10241	2752	29846	7519	81324	15326	108621		
Males (%)	312 (49%)	5,404 (53%)	1,233 (45%)	15,613 (52%)	3,397 (45%)	42,452 (52%)	6,546 (43%)	56,925 (52%)	<0.001	0.987
Age (years), mean (SD)	32.5 (7.4)	66.0 (11.8)	30.9 (8.6)	65.3 (12.1)	31.1 (8.5)	65.1 (12.1)	29.4 (9.4)	64.2 (12.6)	<0.001	<0.001
Smoking status:									0.159	<0.001
n (%)	438 (68%)	7,016 (69%)	2,094 (76%)	25,329 (85%)	6,154 (82%)	74,601 (92%)	13,477 (88%)	106,938 (98%)		
Non-smoker, n (%)	266 (61%)	4,320 (62%)	1,185 (57%)	13,835 (55%)	3,195 (52%)	33,704 (45%)	7,069 (52%)	44,701 (42%)		
Ex-smoker, n (%)	49 (11%)	1,174 (17%)	206 (10%)	5,859 (23%)	889 (14%)	25,664 (34%)	2,639 (20%)	43,431 (41%)		
Current smoker, n (%)	123 (28%)	1,522 (22%)	703 (34%)	5,635 (22%)	2,070 (34%)	15,233 (20%)	3,769 (28)	18,806 (18%)		
HbA1c (%)									<0.001	<0.001
n (%)	57 (9%)	973 (10%)	1,327 (48%)	10,941 (37%)	3,879 (52%)	41,732 (51%)	4,372 (29%)	51,103 (47%)		
mean (SD)	8.3 (3.0)	9.0 (2.9)	6.1 (2.2)	7.6 (2.6)	6.7 (2.5)	7.5 (2.3)	7.4 (2.6)	7.5 (2.2)		
BMI (kg/m2)									<0.001	<0.001
n (%)	244 (38%)	4,367 (43%)	888 (32%)	12,836 (43%)	3,275 (44%)	46,774 (58%)	7,103 (46%)	70,298 (65%)		
mean (SD)	32.2 (7.7)	29.2 (5.3)	31.6 (7.6)	29.9 (5.7)	32.6 (7.7)	30.5 (5.8)	30.8 (8.0)	30.8 (6.1)		
Weight: males (kg)									<0.001	<0.001
n (%)	128 (41%)	2,511 (46)	437 (35%)	7,265 (47%)	1,559 (46%)	25,624 (60%)	3,080 (47%)	38,687 (68%)		
mean (SD)	95.8 (22.5)	86.5 (15.8)	97.5 (25.6)	89.5 (17.1)	100.1 (26.7)	91.7 (17.7)	96.3 (28.3)	93.6 (18.9)		
Weight: females (kg)									<0.001	<0.001
n (%)	120 (36%)	2,040 (42%)	505 (33%)	6,021 (42%)	1,839 (45%)	21,914 (56%)	4,312 (49%)	32,269 (62%)		
mean (SD)	86.3 (22.3)	76.1 (16.3)	83.2 (22.8)	77.7 (17.5)	87.4 (23.8)	79.2 (17.8)	80.3 (24.6)	79.7 (18.8)		
Time to first treatment (years):									<0.001	<0.001
mean (SD)	2.2 (3.4)	2.0 (3.0)	1.7 (2.5)	1.7 (2.4)	1.0 (1.7)	1.4 (2.0)	0.3 (0.7)	0.5 (0.9)		
median (IQR)	0.4 (0.0-3.2)	0.5 (0.0-3.1)	0.4 (0.0-2.4)	0.5 (0.0-2.6)	0.1 (0.0-1.2)	0.4 (0.0-2.3)	0.0 (0.0-0.3)	0.1 (0.0-0.6)		
Blood pressure										

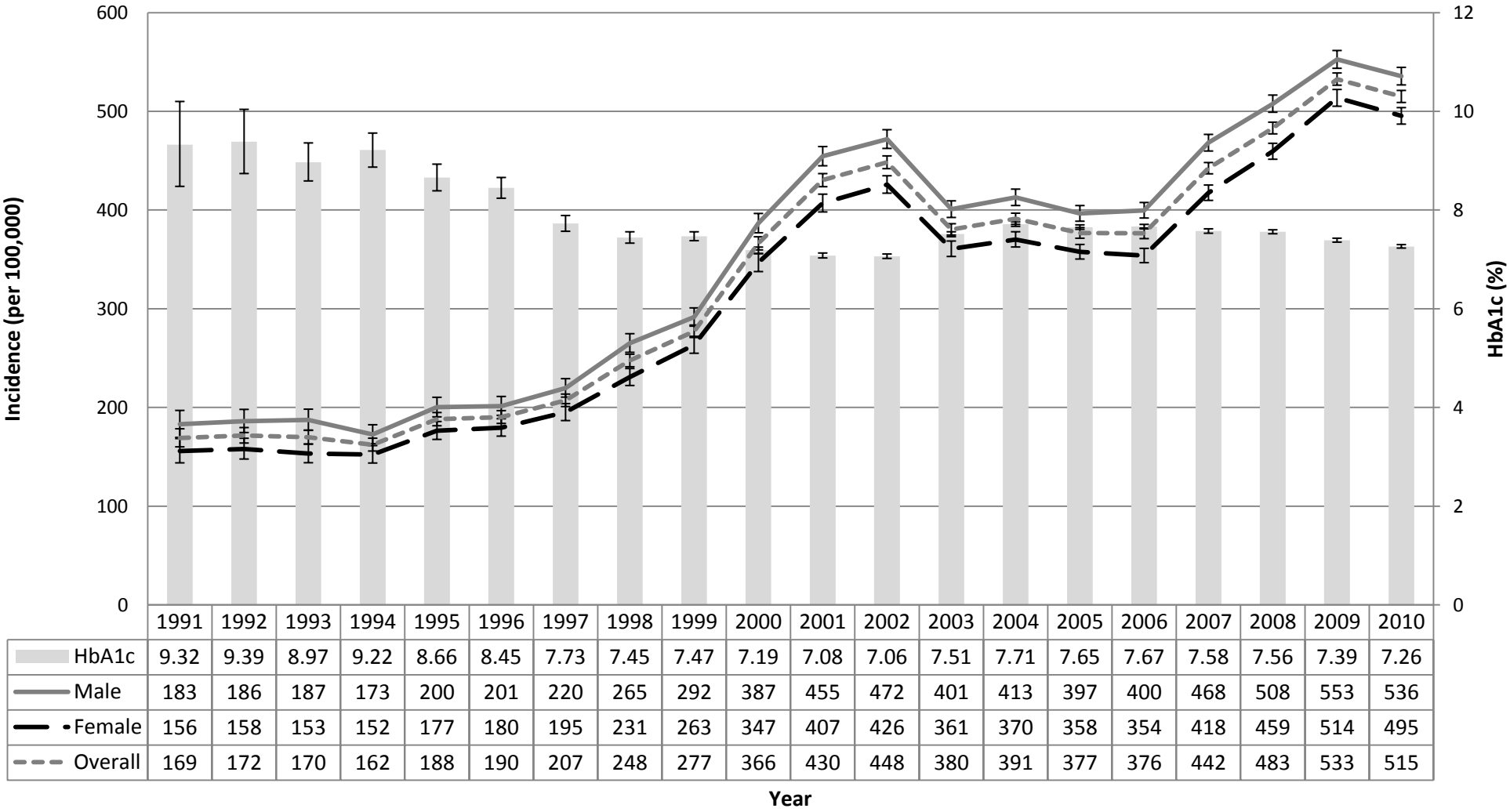
n (%)	309 (48%)	6,241 (61%)	1,335 (49%)	19,765 (66%)	4,543 (60%)	68,199 (84%)	8,962 (58%)	93,307 (86%)		
Diastolic BP, mean (SD)	82.7 (11.1)	85.3 (10.9)	80.7 (12.3)	84.4 (10.7)	81.5 (12.1)	82.5 (11.0)	78.6 (11.8)	80.1 (10.8)	<0.001	<0.001
Systolic BP, mean (SD)	132 (19)	150 (21)	128 (19)	148 (20)	130 (18)	144 (19)	125 (17)	138 (18)	<0.001	<0.001
Number of GP contacts:									<0.001	<0.001
mean (SD)	7.0 (6.5)	8.0 (7.3)	7.2 (7.4)	9.0 (8.3	7.3 (7.8)	9.1 (9.0)	9.1 (9.6)	10.9 (11.0)		
median (IQR)	5.0 (2.0-9.0)	6.0 (3.0-11.0)	5.0 (2.0-10.0)	7.0 (3.0-12.0)	5.0 (2.0-10.0)	7.0 (3.0-12.0)	7.0 (3.0-12.0)	8.0 (4.0-15.0)		
Total chol (mmol/l)									<0.001	<0.001
n (%)	69 (11%)	1,250 (12%)	556 (20%)	9,581 (32%)	2,832 (38%)	54,182 (67%)	5,086 (33%)	82,459 (76%)		
mean (SD)	6.0 (1.3)	6.2 (1.2)	5.5 (1.2)	5.8 (1.2)	5.4 (1.2)	5.5 (1.2)	5.3 (1.2)	5.1 (1.2)		
Charlson Index:									<0.001	<0.001
mean (SD)	1.2 (0.8)	1.7 (1.2)	0.8 (0.8)	1.5 (1.3)	0.8 (0.9)	1.5 (1.3)	1.1 (0.8)	1.8 (1.5)		
median (IQR)	1.0 (1.0-1.0)	1.0 (1.0-2.0)	1.0 (0.0-1.0)	1.0 (1.0-2.0)	1.0 (0.0-1.0)	1.0 (1.0-2.0)	1.0 (1.0-1.0)	1.0 (1.0-3.0)		
Adjusted Charlson Index:									<0.001	<0.001
mean (SD)	1.2 (0.8)	3.8 (2.0)	0.8 (0.8)	3.3 (2.2)	0.8 (0.9)	3.3 (2.3)	1.1 (0.8)	3.6 (2.5)		
median (IQR)	1.0 (1.0-1.0)	4.0 (3.0-5.0)	1.0 (0.0-1.0)	3.0 (2.0-5.0)	1.0 (0.0-1.0)	3.0 (2.0-5.0)	1.0 (1.0-1.0)	3.0 (2.0-5.0)		
Diabetic complications:										
CHD (%)	0 (0.0%)	0 (0.0%)	9 (0.0%)	1011 (3.0%)	49 (1.0%)	5,738 (7.0%)	83 (1.0%)	9,626 (9%)	0.147	<0.001
CVD (%)	0 (0.0%)	0 (0.0%)	1 (0.0%)	324 (1.0%)	14 (0.0%)	1,638 (2.0%)	42 (0.0%)	2,884 (3%)	0.005	<0.001
Diabetic foot and PVD (%)	0 (0.0%)	0 (0.0%)	1 (0.0%)	138 (0.0%)	3 (0.0%)	638 (1.0%)	7 (0.0%)	956 (1%)	0.622	<0.001
Eye-related complications (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.849	<0.001
ESRD (%)	0 (0.0%)	0 (0.0%)	3 (0.0%)	109 (0.0%)	33 (0.0%)	657 (1.0%)	134 (1.0%)	1,756 (2.0%)	<0.001	<0.001

Smoking status was the nearest status recorded prior to the index date. For BMI, HbA1c, weight, blood pressure (BP), total cholesterol the nearest record to the index date was taken, provided it was no more than 365 days prior to or 30 days after the index date. The number of GP contacts represents the number of GP contacts in the year prior to the index date. Diabetic complications refer to whether patient had record of a diabetic complication prior to index date.

Table 2. Standardised incidence ratio (SIR: 1991–1995=100) for five-yearly periods to 2010.

Year group	Observed	Expected	SIR	95% CI		p
All subjects						
1991–1995	10,883	n/a	100			
1996–2000	32,596	20,601	158	157	160	<0.001
2001–2005	88,835	37,545	237	235	238	<0.001
2006–2010	87,970	45,135	275	273	276	<0.001
Males						
1991–1995	5,716	n/a	100			
1996–2000	16,846	10,945	154	152	156	<0.001
2001–2005	45,849	20,209	227	225	229	<0.001
2006–2010	63,471	24,499	259	257	261	<0.001
Females						
1991–1995	5,167	n/a	100			
1996–2000	15,750	9,656	163	161	166	<0.001
2001–2005	42,986	17,336	248	246	250	<0.001
2006–2010	60,461	20,636	293	291	295	<0.001
Under 40 years						
1991–1995	577	n/a	100			
1996–2000	2,496	1,148	217	209	226	<0.001
2001–2005	6,798	2,077	327	320	335	<0.001
2006–2010	14,073	2,352	598	589	608	<0.001

Figure 1. Incidence of type 2 diabetes per 100,000 population by year

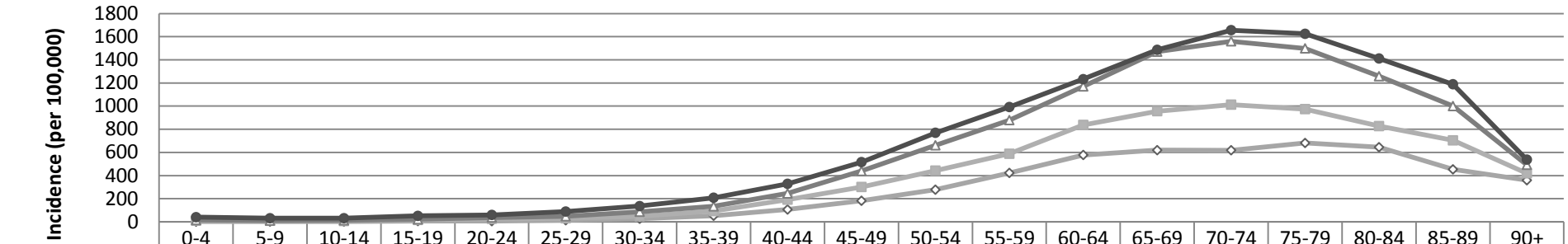


	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HbA1c	9.32	9.39	8.97	9.22	8.66	8.45	7.73	7.45	7.47	7.19	7.08	7.06	7.51	7.71	7.65	7.67	7.58	7.56	7.39	7.26
Male	183	186	187	173	200	201	220	265	292	387	455	472	401	413	397	400	468	508	553	536
Female	156	158	153	152	177	180	195	231	263	347	407	426	361	370	358	354	418	459	514	495
Overall	169	172	170	162	188	190	207	248	277	366	430	448	380	391	377	376	442	483	533	515

Year

Figure 2. Incidence of new cases of type 2 diabetes per 100,000 population by year

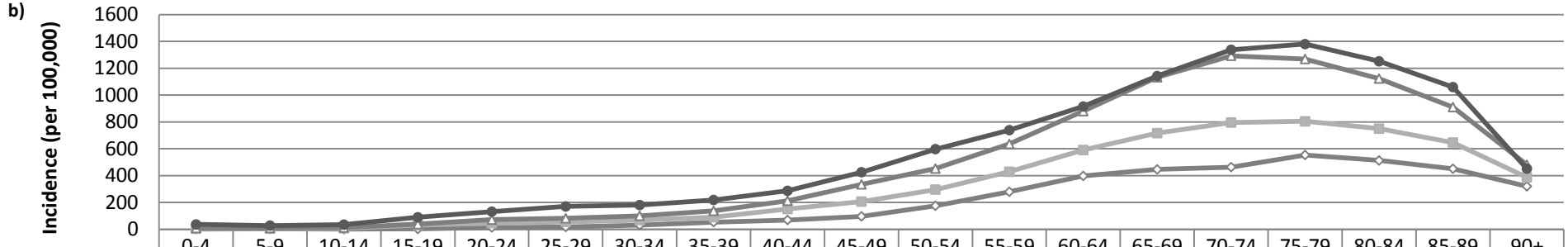
a)



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90+
1991-1995	2	2	2	7	6	14	27	53	107	182	278	423	578	619	619	681	645	453	360
1996-2000	11	10	8	17	26	31	48	93	192	301	443	588	838	956	1013	974	827	704	420
2001-2005	16	11	14	22	38	48	88	134	246	439	661	879	1170	1470	1560	1499	1258	1000	493
2006-2010	40	32	32	52	60	89	136	209	329	516	770	992	1233	1486	1656	1625	1411	1189	538

Year

b)

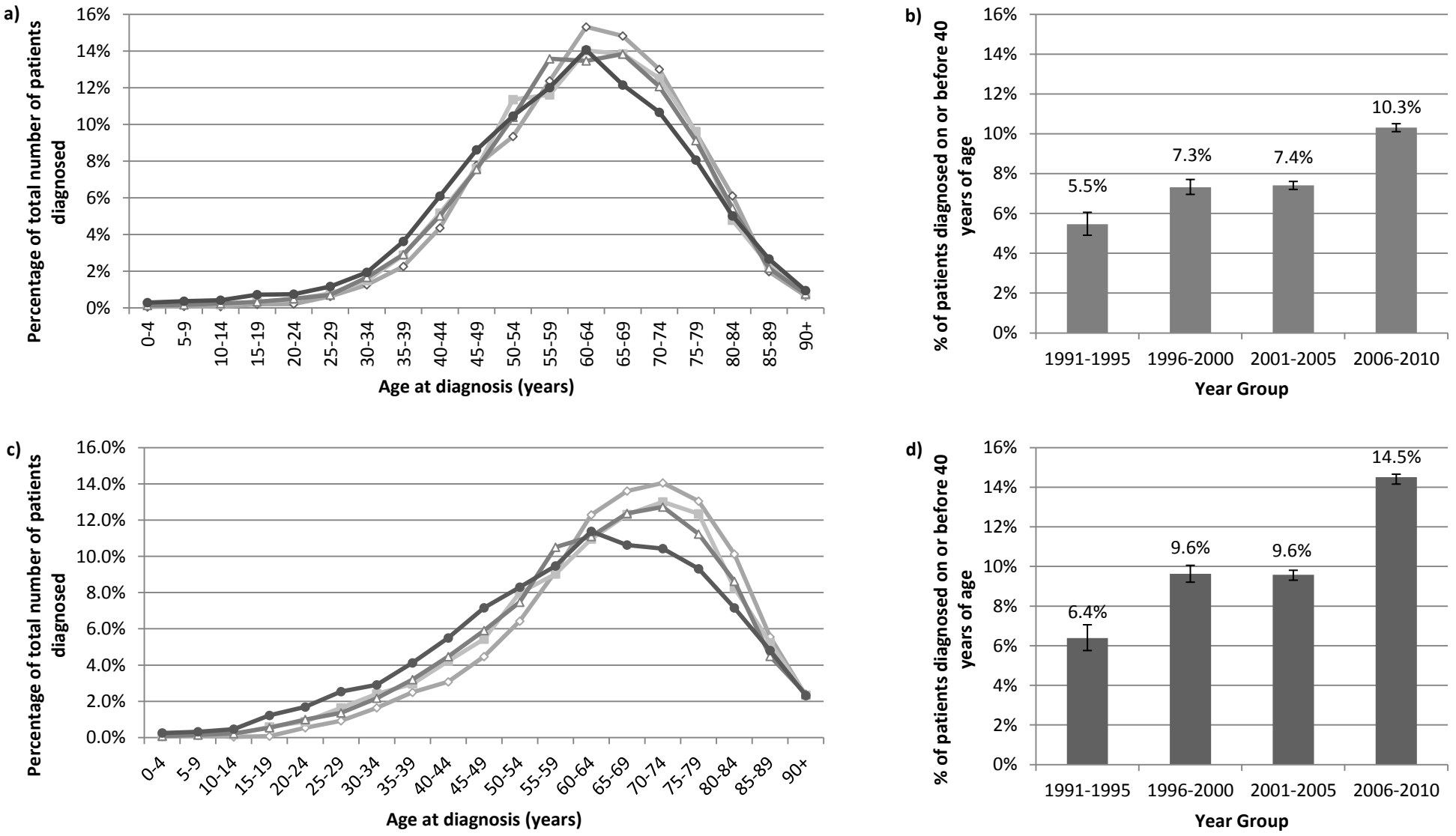


	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90+
1991-1995	2	3	1	3	14	18	31	54	70	97	176	280	398	446	463	554	513	451	320
1996-2000	5	6	8	31	46	56	69	90	151	207	296	429	591	716	795	805	750	647	387
2001-2005	9	10	13	38	72	82	101	137	213	335	453	636	880	1133	1293	1269	1123	911	482
2006-2010	36	28	35	90	132	170	181	219	287	425	597	739	915	1142	1338	1380	1252	1060	452

Year

a) Males and b) females

Figure 3. Percentage of new cases of type 2 diabetes between 1991 and 2010 by age group and calendar period



a) Males, all ages, b) males diagnosed at or before 40 years of age, c) females, all ages, d) females diagnosed at or before 40 years of age
White diamond = 1991–1995, grey square = 1996–2000, white triangle = 2001–2005, black circle = 2006–2010

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